

# Rapid Prototyping Mobile Augmented Reality Applications

## Interim Report October 2012-September 2013

### IMLS Sparks! Grant

Submitted by Project staff:

Jim Hahn, University Library, University of Illinois (PI)

Michael Twidale, Graduate School of Library and Information Science, University of Illinois (Co-PI)

Mayur Sadavarte, Department of Computer Science, University of Illinois (Graduate Student)

#### Introduction:

IMLS Sparks funding began in October 2012. Our charge was to prototype augmented reality applications based around the print collection and using optical character recognition (OCR) tools as an area of experimentation within mobile apps. The major funding for this grant was to support hourly programming talent sourced from the Computer Science department at the University of Illinois.

In the Fall 2012 semester Project Staff interviewed and hired a Graduate CS student for a programmer position on this grant. Programmer worked for two semesters on this project, but was unavailable for full time work during the Summer 2013 semester. Having no programmer during this time we sought and secured a one-year extension to complete project tasks. This report progresses next with a comparison of actual accomplishments during the last year, with goals established for the grant. The next section describes significant findings and accomplishments for the period. We conclude with additional lessons learned and project achievements during the 2012-2013 grant period.

#### Comparison of Actual Accomplishments with Goals Established for the Grant

**Goal 1:** *Computer Science students working with PI will create shelf recognition software for mobile devices that integrate print and digital resources into the on-site library experience and experiment with location based recommendation services. Researchers will study browsing and serendipity aspects in system features.*

Our stated goals of Augmented Reality experimentation where partially realized, after two semesters of work CS graduate student and PI on the grant did complete a functioning Optical Character Recognition software program. Our implementation runs from an Android application.

**Goal 2:** *Hourly programmers and PI will create directional wayfinding support using AR graphics and incorporate into mobile software. Researchers will investigate the*

*potential of creating a system that shows users how they are physically navigating an "idea space."*

This goal was not realized, due to the nature and extent of Optical Character Recognition research, which we learned to be more complex and intensive of a programming undertaking than previously known. PI investigated alternative OCR technologies during the 2012-2013 period, which we will report on in the significant findings section.

***Goal 3:*** *Co-PI will complete iterative rapid use studies of mobile software with library patrons and communicate results back to programming staff for incremental app design. This evaluation will communicate to the broader library field what works for mobile AR apps and what areas are not working. At the completion of the use studies we will be able to specify what set of features are promising for adoption and what features are undesirable for this type of system.*

Rapid use studies are planned for our final year of grant work, most likely Spring 2014 semester. These will be formative in nature. We plan to vet final functionality for the augmented reality services through student preferences and needs while navigating library book stacks.

***Goal 4:*** *Work with Library IT (Software Development Group, and the Infrastructure Management and Support team) to identify skills and technical infrastructure needed in order to make AR an ongoing part of technology in libraries.*

Grant staff participated in the University Library Software Developer Group meeting. We discussed progress toward goals, and worked with the group to brainstorm how best to recruit programmers into this project. We located research groups on campus that do similar pattern recognition work and reached out to these departments during our grant staff-hiring phase of last fall 2012.

***Goal 5:*** *Make available the AR apps through the Library's mobile labs experimental apps area (<http://m.library.illinois.edu/labs.asp>).*

Not applicable since the software hasn't been publicly released. We intend to incorporate this software as a module (<http://minrvaproject.org/developers.php#2>) in the Minrva set of Mobile applications. Packaging the software modularly will help extend it to other library environments, since in the modular conceptualization we can isolate the program from highly customized library ILS systems and focus on portability.

## Significant findings and accomplishments in this period

The operational prototype optical character recognition software achieved a beta implementation status by the spring semester (April 2013). This was a major accomplishment for the grant, and we anticipate that further functionality will be increased through the next year of grant work. We envision that the augmented reality service will rely heavily on this OCR solution. With OCR the call numbers on books can be identified and we can then match the call number to a subject area. Using subject areas, the software can then provide information on popular items near the user, and integrate digital resources such as relevant research databases to the mobile interface.

### *Third Party OCR services*

While this project did develop an OCR solution, we also investigated third party Augmented Reality software. During the Fall 2012 semester staff looked into the Vuforia platform. Our exploration was initially focused on graphics in mobile software, but during the course of the year new releases of the third party software included OCR functionality and these seem like a promising use for libraries without programming staff. We intend to include a more thorough technical analysis in the projects final report on how libraries can either develop or leverage third party software for computer vision.

### *Idea Spaces*

During the past year we more fully fleshed out the conceptualization of idea spaces in the library. The motivation behind idea spaces stems from subject cataloging practice in libraries, where items are assigned multiple subject headings. These multiple headings lead us design a system whereby we show the mobile app user what other locations (shelves) the item *could* have been shelved on, thus more fully operationalizing the serendipity objectives of multiple collocation points for books.

## Other comments and information on project achievements or lessons learned in 2012-2013 period.

The 2012-2013 of grant work was one of extensive learning on the capabilities of optical character recognition in mobile applications. While we had a chosen OCR software package in mind, and programming support to explore this feasibility of OCR, we learned the limitations of homegrown optical character recognition. To make a mobile app generally requires experience in compiled languages like Java, but what we found was that we needed to package the OCR code inside of the Java wrapper.

This is not trivial to do, and poses problems in troubleshooting and debugging code, which happens regularly while designing software. Specifically, we found it challenging to debug the OCR code when it was running inside of a mobile application. For the purposes of this first year of study we chose the Android developer environment since it is open and was a proven research and development test environment from previous studies.

As an additional lessons learned we have targeted the following as improvements to make in OCR apps.

#### *Improved Focus*

Focus for the camera can take 3-4 second to complete its autofocus once the students aim it at words. We want to get to a quicker image recognition in our final app.

#### *Improved Accuracy*

The recognition software has trouble with a few problem characters like “I” and “L” which look similar in training data, and are identified incorrectly in the tests (as with O’s and Zero). Additionally, OCR training data for some letters, such as “C” looks similar in both lower and upper case, such that the lower case “c” is recognized as an upper case “C” in the text string recognition.

#### *Spacing Improvements*

Recognition software as currently designed does not adequately accommodate spacing.

#### *Error Correction*

We found also that the optical character recognition software would benefit from error correction. Currently the target box does not exclude cutoffs e.g. if a partial letter gets scanned that isn’t a part of any section of call number, just exclude that extra portion.

#### ***Other comments and information: Student Interactions with topical coverage of book stacks***

Our development of the interface will make possible the awareness of areas and items that students normally would not easily come across. The “augmented reality” parts of the app are being planned for now. We are actively prototyping two serendipity features:

- 1) After taking a picture of the call number students will be able to see what books are normally shelved in the area, but that are currently checked out.
- 2) After taking a picture of the call number we parse the subjects that are assigned to this book, and then show students what sections of the library may be relevant based on the controlled vocabulary of the item. Our parsing algorithm is in development and may change by grant conclusion, but at this

time we make the assertion that items that are relevant are not always shelved nearby – therefore our design choice is to show students that there are multiple areas of relevance in the print stacks to their topic – e.g. history topics may have relevant areas in economics, biography, political science, and literature, all of which are shelved in multiple other locations of the library print collection.

### *Report Conclusion*

The final year of the grant (2013-2014) will be one in which we solidify the above-mentioned functions of the app, release it for users to download, and do a user study of the augmented reality app functionality.

We intend to release the code so that other libraries can adapt this functionality for use in their libraries; either as a separate stand-alone library app or integrated into their current apps. Project final report will have technical implementation details and higher-level user trends.